

SECTION 2 RULES AND REGULATIONS

2.1 INTRODUCTION

In the United States, the spectrum between 2700 -to 3700-MHz is mainly used by radar stations operating in the radiolocation, aeronautical and maritime radionavigation, and meteorological aids services. The bands included in this part of the spectrum are: 2700-2900, 2900-3100, 3100-3300, 3300-3500, 3500-3600, and 3600-3700 MHz. The band adjacent to these bands, 3700-4200 MHz, is used by fixed-satellite (space-to-earth) earth stations.

This section contains the rules and regulations applicable to systems in these bands. The National allocations, definitions, and applicable footnotes for these bands are discussed along with the applicable spectrum standards for Government and non-Government radar stations and earth stations.

2.2 NATIONAL ALLOCATION RULES

In the United States, the band 2700-2900 MHz is allocated for exclusive Government services (except as indicated in note US18), as listed in Table 1. The Government allocates this band to the aeronautical radionavigation and meteorological aids services on a primary basis, and to military radiolocation on a secondary basis.

The band 2900-3100 MHz is allocated on a shared basis for Government and non-Government maritime radionavigation services. Radiolocation services are secondary in this band. For cases in which the Government NEXRAD weather radar cannot be accommodated in the band 2700-2900 MHz, the band 2900-3000 MHz is allocated to radionavigation and meteorological aids services on a primary basis (see US316).

The bands 3100-3300 MHz and 3300-3500 are allocated on a primary basis to Government radiolocation service. These bands are allocated on a secondary basis to non-Government radiolocation and amateur services (see 664).

The bands 3500-3600 MHz and 3600-3700 MHz are allocated on a primary basis to Government ground-based aeronautical radionavigation services and radiolocation services, and on a secondary basis to the non-Government radiolocation service. The band 3600-3700 MHz is allocated on a primary basis to the non-Government fixed-satellite (space-to-earth) service.

The band 3700-4200 MHz is allocated exclusively to non-Government fixed and fixed-satellite (space-to-earth) services. These services share the band on a primary basis.

TABLE 1.
UNITED STATES FREQUENCY ALLOCATIONS 2700-4200 MHz.

Band (MHz)	PROVISIONS	GOVERNMENT	NON-GOVERNMENT
2700-2900	US18 717, 770 G2, G15	AERONAUTICAL RADIO NAVIGATION METEOROLOGICAL AIDS Radiolocation	
2900-3100	US44, US316 775A G56	MARITIME RADIONAVIGATION Radiolocation	MARITIME RADIO NAVIGATION Radiolocation
3100-3300	US110 713, 778 G59	RADIOLOCATION	Radiolocation
3300-3500	US108 664, 778 G31	RADIOLOCATION	Amateur Radiolocation
3500-3600	US110 G59, G110	AERONAUTICAL RADIONAVIGATION (Ground-based) RADIOLOCATION	Radiolocation
3600-3700	US110, US245 G59, G110	AERONAUTICAL RADIONAVIGATION (Ground-based) RADIOLOCATION	FIXED-SATELLITE (space-to-Earth) Radiolocation
3700-4200	NG41		FIXED FIXED-SATELLITE (space-to-Earth)

US Footnotes

- US18** Navigation aids in the US and possessions in the bands 9-14 kHz, 90-110 kHz, 190-415 kHz, 510-535 kHz, and 2700-2900 MHz are normally operated by the US Government. However, authorizations may be made by the FCC for non-Government operation in these bands subject to the conclusion of appropriate arrangements between the FCC and the Government agencies concerned end upon special showing of need for service which the Government is not yet prepared to render.
- US44** The non-Government radiolocation service may be authorized in the band 2900-3100 MHz on the condition that no harmful interference is caused to Government services.
- US108** Within the bands 3300-3500 MHz and 10000-10500 MHz, survey operations, using transmitter with a peak power not to exceed five watts into the antenna, may be authorized for Government and non-Government use on a secondary basis to other Government radiolocation operations.
- US110** In the frequency bands 3100-3300 MHz, 3500-3700 MHz, 5250-5350 MHz, 8500-9000 MHz, 9200-9300 MHz, 9500-10000 MHz, 13.4-14.0 GHz, 15.7-17.3 GHz, 24.05-24.25 GHz and 33.4-36 GHz, the non-Government radiolocation service shall be secondary to the Government radiolocation service and to airborne doppler radars at 8800 MHz, and shall provide protection to airport surface detection equipment (ASDE) operating between 15.7-16.2 GHz.

Table 1. United States Frequency Allocations 2700-4200 MHz (continued)

US245 This Fixed-Satellite Service is limited to International inter-Continental systems and subject to case-by-case electromagnetic compatibility analysis.

US316 This band 2900-3000 MHz is also allocated on a primary basis to the Meteorological Aids Service. Operations in this service are limited to Government Next Generation Weather Radar (NEXRAD) systems where accommodation in the 2700-2900 MHz band is not technically practical and are subject to coordination with existing authorized stations.

International Footnotes

- 664 In the bands 435-438 MHz, 1260-1270 MHz, 2400-2450 MHz, 3400-3410 MHz (in Regions 2 and 3 only) and 5650-5670 MHz, the amateur-satellite service may operate subject to not causing harmful interference to other services operating in accordance with the Table (see No. 435). Administrations authorizing such use shall ensure that any harmful interference caused by emissions from a station in the amateur-satellite service is immediately eliminated in accordance with the provisions of No. 2741. The use of the bands 1260-1270 MHz and 5650-5670 MHz by the amateur-satellite service is limited to the Earth-to-space direction.
- 713 In the bands 1215-1300 MHz, 3100-3300 MHz, 5250-5350 MHz, 8550-8650 MHz, 9500-9800 MHz and 13.4-14.0 GHz, radiolocation stations installed on spacecraft may also be employed for the earth exploration-satellite and space research services on a secondary basis.
- 717 The use of the bands 1300-1350 MHz, 2700-2900 MHz and 9000-9200 MHz by the aeronautical radionavigation service is restricted to ground-based radars and to the associated airborne transponders which transmit only on frequencies in these bands and only when actuated by radars operating in the same band.
- 770 In the band 2700-2900 MHz, ground-based radars used for meteorological purposes are authorized to operate on a basis of equality with stations of the radionavigation service.
- 775A In the bands 2900-3100 MHz and 9300-9500 MHz, the response from radar transponders shall not be capable of being confused with the response from radar beacons (racons) and shall not cause interference to ship or aeronautical radars in the radionavigation service, having regard, however, to No. 347 of these Regulations.
- 778 In making assignments to stations of other services, administrations are urged to take all practicable steps to protect the spectral line observations of the radio astronomy service from harmful interference in the bands 3260-3267 MHz, 3332-3339 MHz, 3345.8-3352.5 MHz and 4825-4835 MHz. Emissions from space or airborne stations can be particularly serious sources of interference to the radio astronomy service (see Nos. 343 and 344 and Article 36).

Government Footnotes

- G2 In the bands 216-225, 420-450 (except as provided by US217), 890-902, 928-942, 1300-1400, 2300-2450, 2700-2900, 5650-5925, and 9000-9200 MHz, the Government radiolocation is limited to the military services.
- G15 Use of the band 2700-2900 MHz by military fixed and shipborne air defense radiolocation installations will be fully coordinated with the meteorological aids and aeronautical radionavigation services. The military air defense installations will be moved from the band 2700-2900 MHz at the earliest practicable date. Until such time as military air defense installations can be accommodated satisfactorily elsewhere in the spectrum, such operations will, insofar as practicable, be adjusted to meet the requirements of the aeronautical radionavigation service.
- G31 In the bands 3300-3500 MHz, the Government radiolocation is limited to the military services, except as provided by footnote US 108.
- G56 Government radiolocation in the bands 1215-1300, 2900-3100, 5350-5650 and 9300-9500 MHz is primarily for the military services; however, limited secondary use is permitted by other Government agencies in support of experimentation and research programs. In addition, limited secondary use is permitted for survey operations in the band 2900-3100 MHz.

Table 1. United States Frequency Allocations 2700-4200 MHz (continued)

G59	In the bands 902-928 MHz, 3100-3300 MHz, 3500-3700 MHz, 5250-5350 MHz, 8500-9000 MHz, 9200-9300 MHz, 13.4-14.0 GHz, 15.7-17.7 GHz and 24.04-24.25 GHz, all Government non-military radiolocation shall be secondary to military radiolocation, except in the subband 15.7-16.2 GHz airport surface detection equipment (ASDE) is permitted on a co-equal basis subject to coordination with the military departments.
G110	Government ground-based stations in the aeronautical radionavigation service may be authorized between 3500 and 3700 MHz where accommodation in the 2700-2900 MHz band is not technically and/or economically feasible.

Non-Government Footnotes

NG41	Frequencies in the bands 3700-4200 MHz, 5925-6425 MHz, and 10.7-11.7 GHz may also be assigned to stations in the international fixed public and international control services located in the U.S. Possessions in the Caribbean area.
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2.3 SPECTRUM STANDARDS (Government and Non-Government)

The following is a summary of spectrum standards pertaining to Government and Non-Government radar stations and non-Government 4-GHz earth stations. Only spectrum standard requirements that affect the electromagnetic compatibility between radar stations and earth stations are discussed in detail.

Government Spectrum Standards

Chapter 5 of the NTIA Manual contains the Radio Frequency Spectrum Standards that are applicable to Federal radio stations and systems. However, within the Federal Government, any Government agency may promulgate more stringent standards for its own use.

Radar Spectrum Engineering Criteria

The Radar Spectrum Engineering Criteria (RSEC) apply to all Government radar systems. RSEC specifications are contained in Section 5.3 of the NTIA Manual. The RSEC specifies certain equipment characteristics to ensure an acceptable degree of electromagnetic compatibility among radar systems, and between such systems and those of other radio services sharing the radio spectrum.

The complete RSEC description is omitted herein; the following list identifies the technical radar characteristics for which the RSEC specifies limits:

- 1) emission bandwidth
- 2) emission level relative to the level of the radar fundamental
- 3) antenna pattern
- 4) frequency tolerance
- 5) frequency tunability
- 6) image and spurious rejection
- 7) local oscillator radiation.

The emission level, which specifies spurious emission limits, is the only technical radar characteristic listed above that has any pertinence since the 4-GHz earth stations operate in bands adjacent to the 2700- to 3700-MHz radar stations. The RSEC spurious emission level requirement is specified in decibels, X, relative to the peak power radiated at the radar fundamental. Extended spectral emissions which are limited by this suppression level are called *spurious emissions*. Procedures for measurement of radar emission characteristics are documented in an NTIA report² and are described summarily in this report's appendix.

Since the initial adoption of the RSEC emission level specification (including spurious emission limits) by NTIA in 1973, there have been several revisions to the RSEC limits. The applicable limits on radar spurious emissions are determined by the procurement date of the radar system. The following is a summary, in chronological order, of spurious emission limits applicable to radar stations operating in the 2700- to 3700-MHz bands.

For all radars that were developed, and subsequent procurement contracts let, between 1 January 1973 and 1 October 1977, the RSEC spurious emission level limit is (IRAC Doc. #13898/2):

$$\begin{aligned} X \text{ (dB)} &= 40 \text{ dB, or} \\ X \text{ (dB)} &= P_t - 20 \log_{10}(F_0) + 100 \end{aligned} \quad \left. \begin{array}{l} \rceil \\ \text{---} \\ \rfloor \end{array} \right\} \text{whichever value is larger.} \quad (1)$$

Where:

P_t	=	$P_p + 20 \log_{10}(DC) + 10 \log_{10}(1000/PRR)$
$X(\text{dB})$	=	spurious emission level relative to the peak power
F_0	=	fundamental operating frequency, MHz
P_p	=	peak transmitted power, dBm
DC	=	duty cycle = $t \times PRR \times 10^{-6}$
PRR	=	pulse repetition rate, pulses per second
t	=	pulse width at 50% amplitude (voltage) points, μs .

For all radars that were developed, and subsequent procurement contracts let, after 1 October 1977, the RSEC spurious emission level limit is:

$$\begin{aligned} X \text{ (dB)} &= 60 \text{ dB, or} \\ X \text{ (dB)} &= P_t + 30 \end{aligned} \quad \left. \begin{array}{l} \rceil \\ \text{---} \\ \rfloor \end{array} \right\} \text{whichever value is larger.} \quad (2)$$

Where:

P_t	=	$P_p + 20 \log_{10}(Nt) + 10 \log_{10}(PRR) - PG - 90$
N	=	total number of chips (sub-pulses) contained in a pulse ($N = 1$ for non-FM and FM pulse radars)

² J. Sell, "Measurement Procedures for the Radar Spectrum Engineering Criteria," NTIA Report 84-157, U.S. Department of Commerce, National Telecommunications and Information Administration, August 1984.

PG	=	processing gain, dB; = 0 for non-FM, non-coded pulse radars
	=	$10 \log_{10}(d)$ for FM pulse radars
	=	$10 \log_{10}(N)$ for coded pulse radars
t	=	pulse width (t = chip width for coded pulse radars), μ s
d	=	pulse compression ratio = emitted pulse duration/compressed pulse duration (at 50% amplitude points).

For all fixed radars in the 2700- to 2900-MHz band which were developed and for which subsequent procurement contracts were let after 1 October 1982 (IRAC Dec. #22834), the RSEC spurious emission level, X(dB), is 80 dB below the maximum spectral power density. In addition, all harmonic frequencies shall be at a level that is at least 60 dB below the maximum spectral power density.

Non-Government Spectrum Standards

All technical standards pertaining to non-Government radiolocation and maritime radionavigation stations may be found in CFR Title 47, Part 90. For non-Government radar stations the spurious emission suppression limit, X decibels, is given by:

$$\begin{array}{lcl} X \text{ (dB)} = & 43 + 10 \log_{10}(P_{\text{ave}}), \text{ or} & \text{ } \\ X \text{ (dB)} = & 80 & \text{ } \end{array} \quad \left. \begin{array}{l} \text{ } \\ \text{ } \end{array} \right\} \text{whichever attenuation is less.} \quad (3)$$

Where: P_{ave} = mean output power, watts
 = peak power, watts, x duty cycle.

The FCC Part 90 regulation for non-Government radars is roughly comparable to the NTIA RSEC for Government radars. However, a direct comparison between these two standards is difficult to make, as these two standards specify different spectrum measurement procedures (e.g., average power measurements vs. peak power measurements).

Non-Government Fixed-Satellite Earth Station Standards

All technical standards pertaining to non-Government earth stations may be found in CFR Title 47, Part 25. The only standards applied to receive-only earth stations are for antenna characteristics (§ 25.209). The FCC generally declines to establish effective receiver system interference immunity standards and lets the marketplace reach a consensus on system design.

The antenna performance standard for receiving earth stations in directions other than the geostationary satellite plane and outside the main beam requires that the gain of the antenna patterns shall lie below the envelope specified by CFR Title 47, § 25.209 (c) as follows:

$$\begin{array}{ll} 32-25 \log_{10}(\Theta) \text{ dBi} & 1^\circ \leq \Theta \leq 48^\circ \\ -10 \text{ dBi} & 48^\circ < \Theta \leq 180^\circ \end{array}$$

where Θ is the angle in degrees from the axis of the main lobe, and dBi refers to decibels relative to an isotropic radiator.

2.4 POLICY REGARDING SPURIOUS EMISSION INTERFERENCE

The Government policy regarding interference due to spurious emissions is contained in the NTIA Manual, Chapter 2, Section 2.3.7 and states:

“In principle, spurious emissions from stations of one radio service shall not cause harmful interference to stations of the same or another radio service within the recognized service areas of the latter stations, whether operated in the same or different frequency bands.

Providing that appropriate spectrum standards in Chapter 5 of the NTIA Manual are met, an existing station is recognized as having priority over a new or modified station. Nevertheless, engineering solutions to mitigate interference may require the cooperation of all involved parties in the application of reasonable and practicable measures to avoid causing or being susceptible to harmful interference. ”

The non-Government policy regarding interference due to spurious emissions from radiolocation stations is contained in CFR Title 47, Part 90, § 90.209(e) and states:

“When radiation in excess of that specified in paragraphs (c) and (d) above of this section results in harmful interference, the Commission may require, among other available remedies, appropriate technical changes in equipment to alleviate the interference. ”

CFR Title 47 does not contain a policy regarding interference due to spurious emissions when the interfering system is in conformance with all applicable spectrum standards.